Tactical Load Carriage: Conditioning and Reconditioning

Orr, Rob Marc

TACTICAL LOAD CARRIAGE: CONDITIONING AND RECONDITIONING

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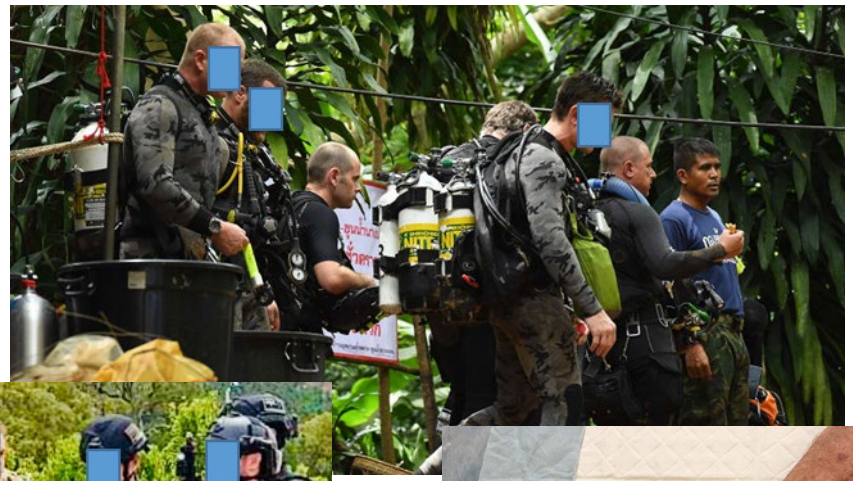
INTRODUCTION TO TACITCAL PERSONNEL

General Requirements

- Physical
  - Diverse
  - Unpredictable
- Specialist Requirements
  - High risk scenarios
  - Special weaponry & PPE
  - Metabolic requirements
  - Musculoskeletal strength



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LOAD CARRIAGE: CONTEXT AND RISKS

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CURRENT CONTEXT – MILITARY

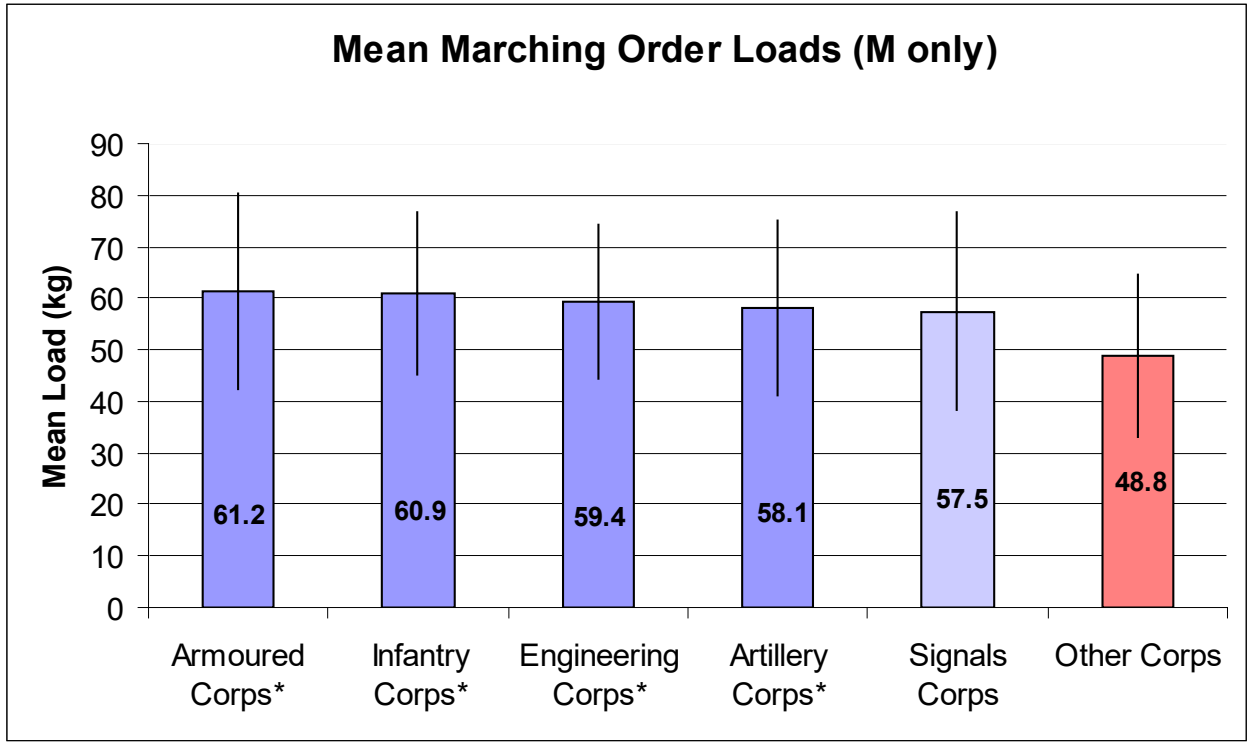
* The current loads (Army)

- PO loads
  - M=28.4 ± 10.0 kg
    - heaviest mean load in 2008 (M=36.9±10.8 kg)
- MO loads
  - M=56.7 ± 15.3 kg
    - heaviest mean load in 2009 (M=65.1 ±16.3 kg)
- OVERALL loads
    - 47.7±21.0 kg, (mean range over 10 years = 40.7 kg to 50.9 kg)

Orr, R., Pope, R., Johnston, V. & Coyle, J. (2015). Operational Loads Carried by Australian Soldiers on Military Operations. Journal of Health, Safety and the Environment, 31(1), 451-457 & Orr R. (2010) The History of the Soldier's Load. Australian Army Journal VII(2):67-88

CURRENT CONTEXT – MILITARY

* Loads can vary within the same tactical service (e.g. Army by corps)



Orr, R., Pope, R., Johnston, V. & Coyle, J. (2015). Operational Loads Carried by Australian Soldiers on Military Operations. Journal of Health, Safety and the Environment, 31(1), 451-457.

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CURRENT CONTEXT – MILITARY

* Loads can vary within the same tactical service (e.g., Army by gender)

ABSOLUTE LOADS	*RELATIVE LOADS*
FEMALE: M = 26.4 kg	FEMALE: M = 43%
MALE: M = 39.0 kg	MALE: M = 47%
p=.045	**p=.55**

Orr, R., Pope, R., Johnston, V. & Coyle, J. (2015). Operational Loads Carried by Australian Soldiers on Military Operations. Journal of Health, Safety and the Environment, 31(1), 451-457.

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CURRENT CONTEXT – MILITARY

* Loads can vary within the same tactical service (e.g. Army by %BW)

ABSOLUTE LOADS

Light 20%: M = 34.7 kg

Heavy 20%: M = 35.7 kg

p=.902

RELATIVE LOADS

Light 20%: M = 49%

Heavy 20%: M = 36%

p=.0509

Orr, R., Pope, R., Johnston, V. & Coyle, J. (2015). Operational Loads Carried by Australian Soldiers on Military Operations. Journal of Health, Safety and the Environment, 31(1), 451-457.

CURRENT CONTEXT – MILITARY

‘ … the loads carried by US [21,28,29,30], British [31], Spanish [18], and German [32,33,34] soldiers can weigh from approximately 25 kg to well over 45 kg’.

Open Access Review

Soldier Load Carriage, Injuries, Rehabilitation and Physical Conditioning: An International Approach

by Robin Orr [1,*], Rodney Pope [1,2], Thiago Jambo Alves Lopes [3,4], Dieter Leyk [5,6], Sam Blacker [7], Beatriz Sanz Bustillo-Aguirre [8,9] and Joseph J. Knapik [1,10]

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Orr R, Pope R, Lopes TJA, Leyk D, Blacker S, Bustillo-Aguirre BS, et al. (2021) Soldier Load Carriage, Injuries, Rehabilitation and Physical Conditioning: An International Approach. International Journal of Environmental Research and Public Health;18(8):4010.

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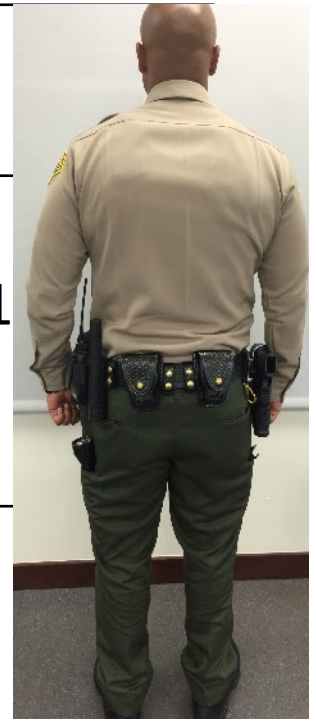
CURRENT CONTEXT – LAW ENFORCEMENT

* The current loads (Law enforcement - GD)

	FEMALE (n=43)	MALE (n=203)
Age (yrs)	30.60±4.56	30.86±6.09
Body Wt (Kg)	68.78±10.96*	89.27±13.31
Load Wt (Kg)	9.99±1.66*	10.87±1.71
Relative load (%)	13.36±2.46*	11.50±2.24



Baran, K. Dulla, J., Orr, R., Dawes, J. & Pope, R. (2018). Duty loads carried by the LA Sheriff's Department Officers Journal of Australian Strength and Conditioning, 26(5), 34-38.

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CURRENT CONTEXT – LAW ENFORCEMENT

* The current loads (Law enforcement - PTG)

SWAT LOADS = 22-25kg

Excluding specialised equipment

Carbone P, Carlton S, Orr R, & Robinson J. (2013) The Impact of Load Carriage on Mobility and Marksmanship of the Tactical Response Officer. Journal of Australian Strength and Conditioning: 2013, 105-106 & Irving, S., Orr, R., & Pope, R. (2019). Profiling the occupational tasks and physical conditioning of specialist police. International journal of exercise science, 12(3), 173.

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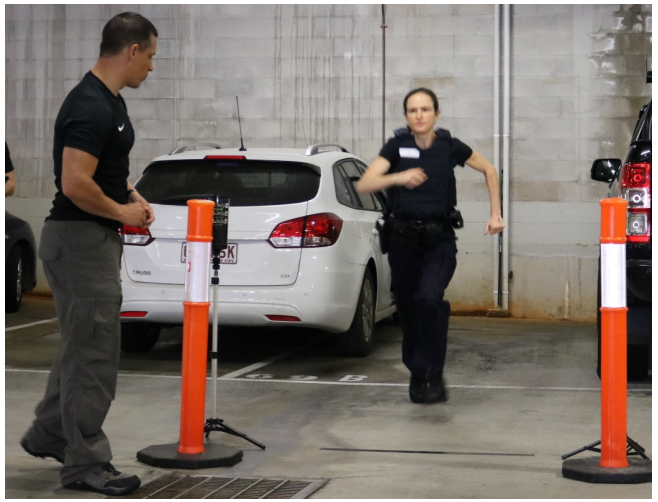
CURRENT CONTEXT – LAW ENFORCEMENT



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CURRENT CONTEXT – FIRE FIGHTERS

* The current loads (Fire)

	MEAN ± SD
Age (yrs)	34.14 ± 7.69
Years of Experience (yrs)	7.00 ± 8.18
Unloaded Weight (kg)	90.96 ± 9.65
Weight of Supervisor PPE (kg)	**11.03 ± 0.10**
Weight of Firefight PPE-FF (kg)	**22.61 ± 0.31**
Relative Weight of PPE (% body weight)	**13.13 ± 0.05**
Relative Weight of PPE-FF (% body weight)	**22.23 ± 2.18**

Walker, A., Pope, R., Schram, B., Gorey, R., & Orr, R. (2019). The Impact of Occupational Tasks on Firefighter Hydration During a Live Structural Fire. Safety, 5(2), 36. Retrieved from https://www.mdpi.com/2313-576X/5/2/36

* The current loads (Fire)

Position	Driver	Firefighter	Officer	Paramedic
Age (yrs)	41.89 ±8.22	35.63 ± 8.67	49.85 ± 6.48	39.00 ± 10.24
Height (cm)	175.61± 8.73	178.17 ± 6.12	176.39 ± 4.86	178.16 ± 4.65
Weight (kgs)	93.01± 16.16	87.55 ± 12.17	90.50± 15.16	88.45 ± 10.35
BMI	30.15 ± 4.41	27.49 ± 3.17	28.59 ± 4.22	27.82 ± 2.74
PPE Load (kgs)	**27.25 ±6.27**	**27.99 ± 1.92**	**27.00± 2.01**	**28.02 ± 2.177**
PPE Load (%bw)	**30.49 ± 10.46**	**32.57 ± 4.99**	**30.40 ± 4.58**	**32.10 ± 4.67**

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CURRENT CONTEXT

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CURRENT CONTEXT – IMPACTS

- Weight: ↑ in load weight = ↑ in the energy cost of standing, walking (forwards and backwards, up and down stairs) and running

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CURRENT CONTEXT – IMPACTS

- Speed: ↑ in speed of load carriage = ↑ in the energy cost of carrying given load (more than weight)?
  - ↑ *0.5km/h= ↑10kg*

Carlton, S. D., & Orr, R. M. (2014). The impact of occupational load carriage on carrier mobility: a critical review of the literature. International journal of occupational safety and ergonomics, 20(1), 33-41.

CURRENT CONTEXT – IMPACTS

- Terrain grade: ↑ in gradient of load carriage = ↑ in the energy cost of carrying given load (more than weight)?
  - ↑ *1%= ↑10kg*

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CURRENT CONTEXT – IMPACTS

- Terrain Types: Different terrains types will elicit different energy cost requirements

  (road-light brush-heavy brush-sand)

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CURRENT CONTEXT – IMPACTS

- Position of load: Differences in load placement will elicit differences in energy cost.
  - Weight on the feet more costly than the back
  - Thigh more costly that back (0.5kg increases cost by 3.5%)
  - Waist less costly than back (use of waist belts on packs)
  - Shoulder more costly than back

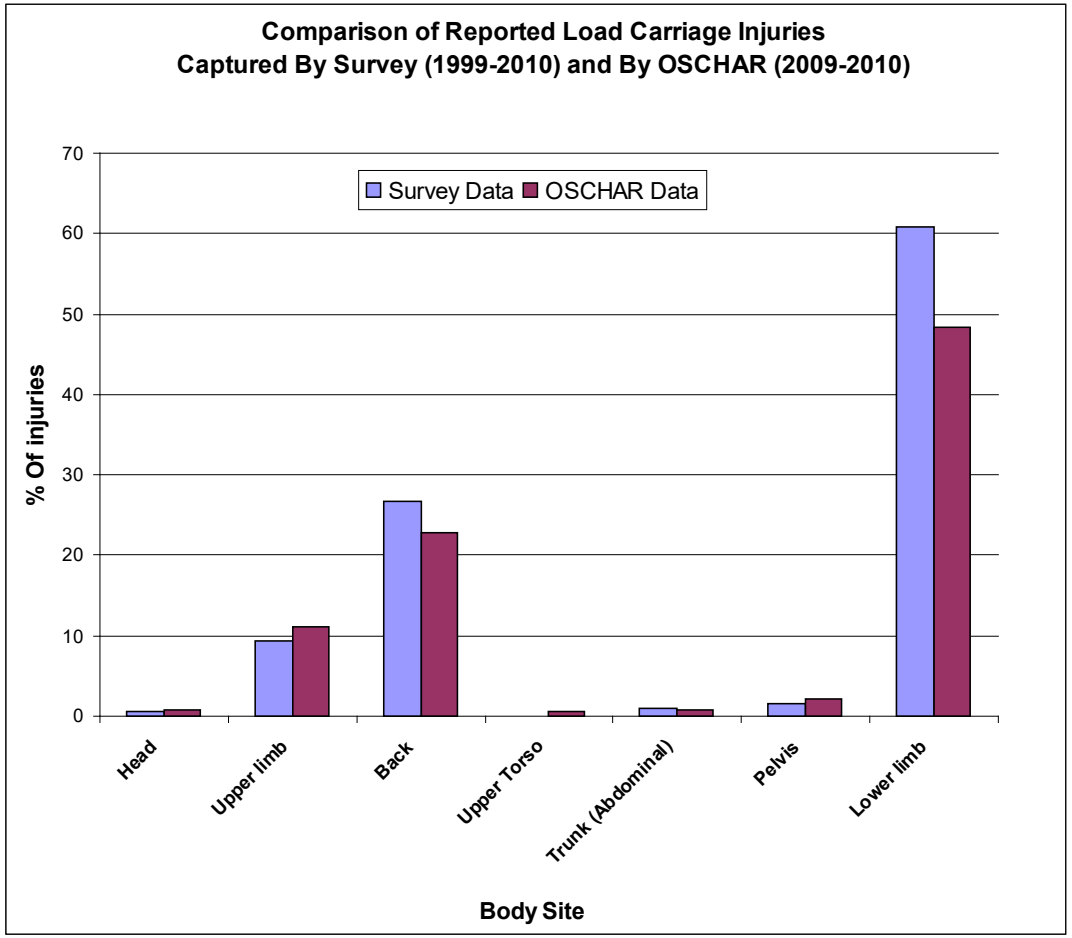
CURRENT CONTEXT – IMPACTS

- Load specific injuries: Associated with a variety of injuries (from skin blistering to muscle, ligament, tendon, bone and nervous system injuries)

Orr, R., Pope, R., Johnston, V. & Coyle, J. (2014). Reported Load Carriage Injuries: An Australian Army Soldier Profile, Journal of Occupational Rehabilitation, 25:316–322, Knapik, J., Reynolds, K., Orr, R. & Pope,R (2017). Load Carriage–Related Paresthesias: Part 2 Meralgia, Journal of Special Operations Medicine, 17(1) pp. 25-31. & Knapik, J., Reynolds, K., Orr, R. & Pope,R (2016). Load Carriage–Related Paresthesias: Part 1: Rucksack Palsy and Digitalgia Paresthetica, Journal of Special Operations Medicine, 15 (4), 37-42

CURRENT CONTEXT – IMPACTS

- Load specific injuries: By site of injury



Orr. R., Pope, R., Coyle, J. & Johnston, V. (2016). Self-reported load carriage injuries in Australian Regular Army soldiers, International Journal of Injury Control and Safety Promotion, pp. 1-9
http://dx.doi.org/10.1080/17457300.2015.1132731

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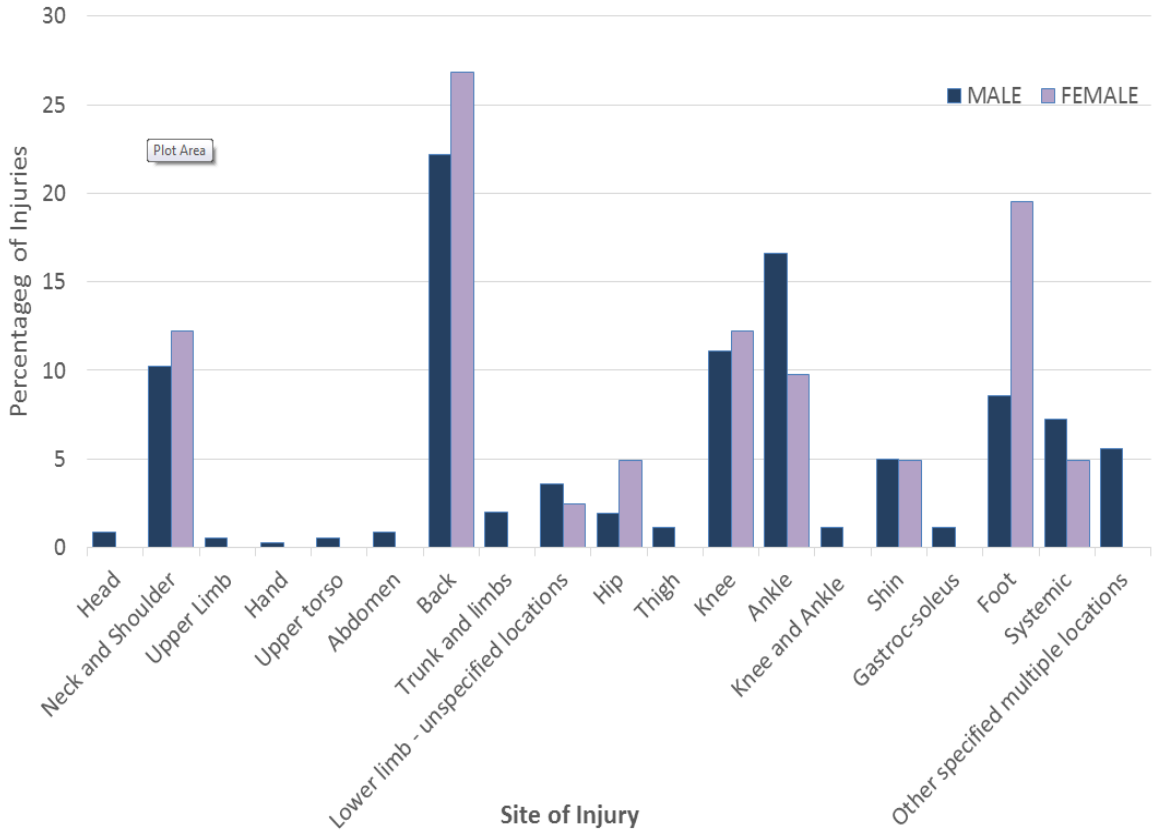
CURRENT CONTEXT – IMPACTS

- Load carriage specific injuries: By gender:
- RR for female soldiers compared to males where found to be similar (RR= 1.02: 95% CI 0.74 to 1.41)
- For female soldiers the RR of SPI was notably higher (RR= 2.40: 95% CI 0.98 to 5.88)
  - The lower back was the most common site of injury and SPI for both genders

Orr, R. & Pope, R. (2016) Gender Differences in Load Carriage Injuries of Australian Army Soldiers, BMC Musculoskeletal Disorders, 17 (488), pp. 1-8. DOI 10.1186/s12891-016-1340-0

CURRENT CONTEXT – IMPACTS

- Load carriage specific injuries: By gender:



Orr, R. & Pope, R. (2016) Gender Differences in Load Carriage Injuries of Australian Army Soldiers, BMC Musculoskeletal Disorders, 17 (488), pp. 1-8. DOI 10.1186/s12891-016-1340-0

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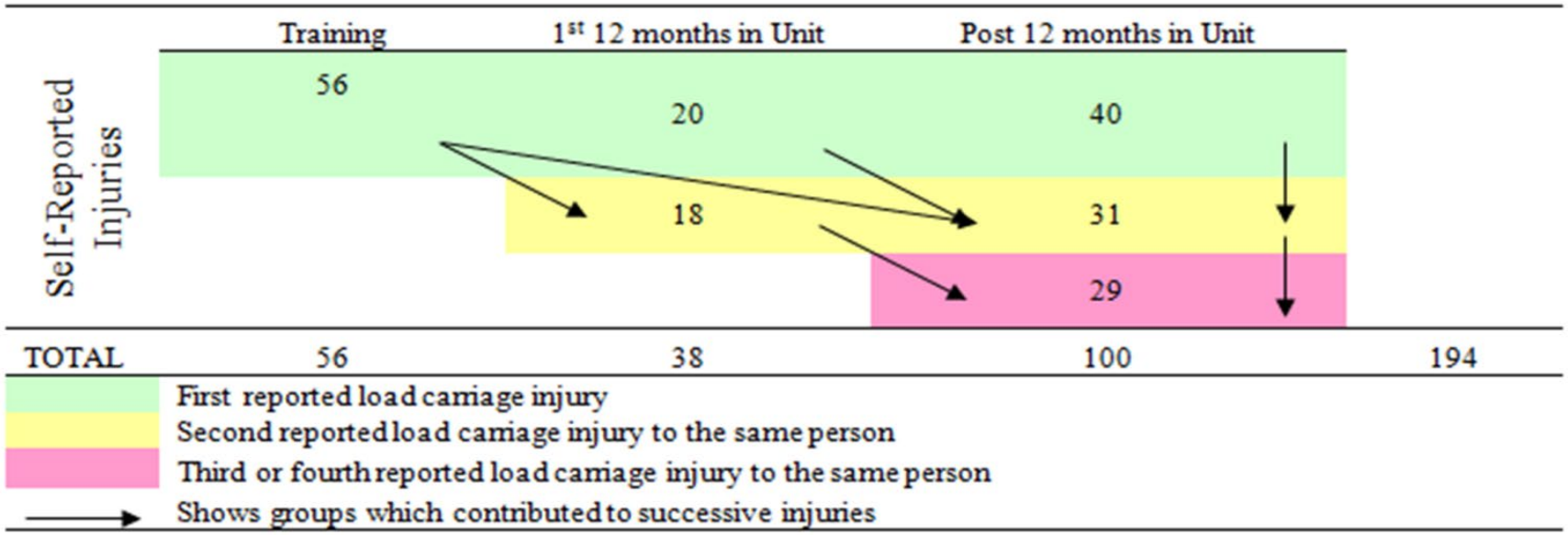
CURRENT CONTEXT – IMPACTS

- Once injured – more likely to be reinjured



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CURRENT CONTEXT – IMPACTS

- Decrements in performance:
  - ↓ Mobility

Australian Fire Season 2013 – Firestorm moved at speeds of up to 31-37 mi/h

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CURRENT CONTEXT – IMPACTS

- Decrements in performance:
  - ↓ **Mobility**
    - Impeded mission success

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CURRENT CONTEXT – IMPACTS

- Decrements in performance:
  - ↓ Mobility

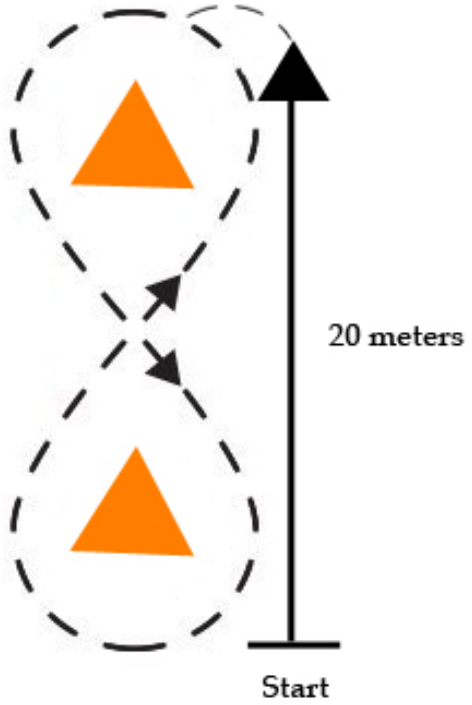
	Unloaded	Loaded
10m sprint (sec)	2.40 ± 0.22	2.46 ± 0.15
10m dummy drag (sec)	6.89 ± 0.44	7.79 ± 0.75*
Total time (sec)	9.29 ± 0.53	10.25 ± 0.77*

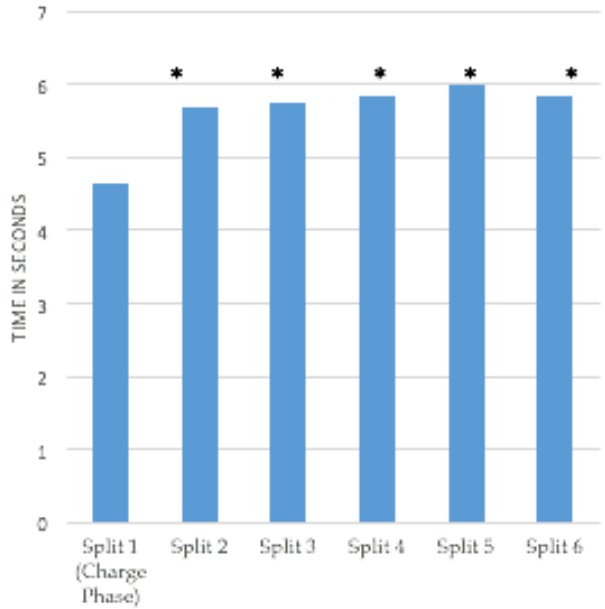
* Indicates statically significant differences between unloaded and loaded, p<0.01.

Carlton, S. D., Carbone, P. D., Stierli, M., & Orr, R. M. (2014). The impact of occupational load carriage on the mobility of the tactical police officer. Journal of Australian Strength and Conditioning, 21(1), 32-37.

CURRENT CONTEXT – IMPACTS

- Decrements in performance:
  - ↓ Mobility





Joseph, A., Wiley, A., Orr, R., Schram, B., & Dawes, J. J. (2018). The impact of load carriage on measures of power and agility in tactical occupations: A critical review. International journal of environmental research and public health, 15(1), 88.

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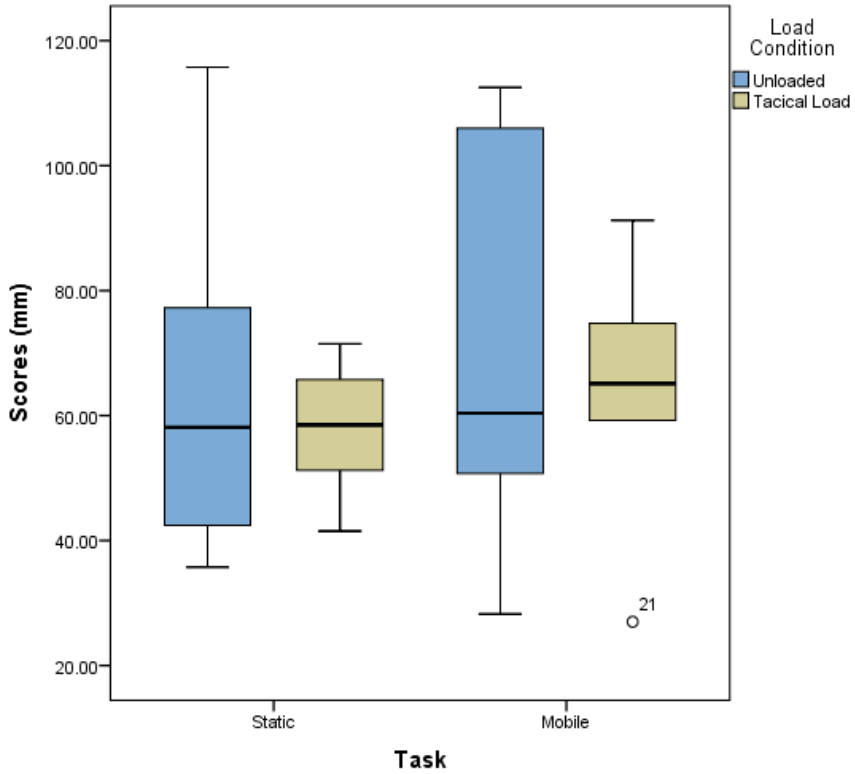
CURRENT CONTEXT – IMPACTS

- Decrements in performance:
  - ↓ Lethality
    - Marksmanship

CURRENT CONTEXT – IMPACTS

- Decrements in performance:
  - ?Lethality



Carbone, P. D., Carlton, S. D., Stierli, M., & Orr, R. M. (2014). The impact of load carriage on the marksmanship of the tactical police officer: a pilot study. *J. Aust. Strength Cond*, *22*(2), 50-57.

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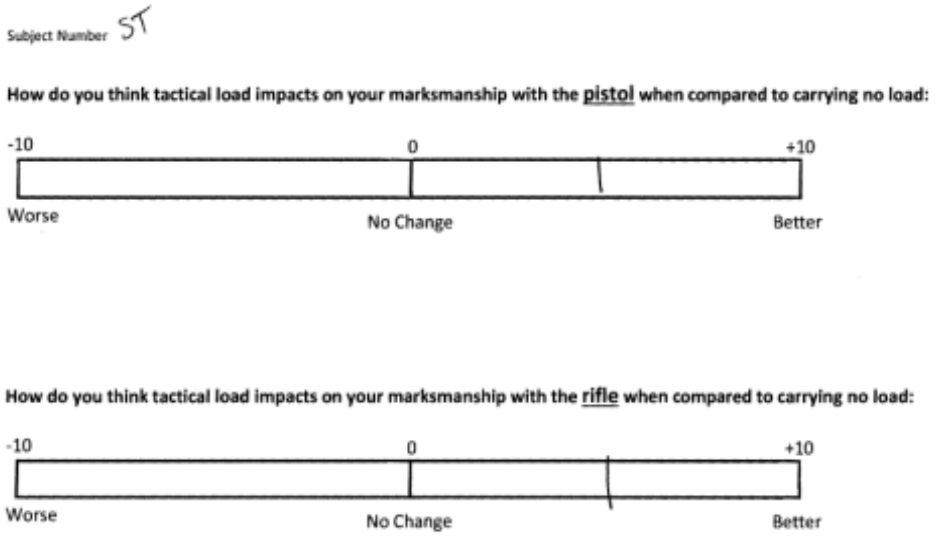
CURRENT CONTEXT – IMPACTS

- Decrements in performance:
  - ?Lethality


Subject Number ST

How do you think tactical load impacts on your marksmanship with the pistol when compared to carrying no load:

-10 0 +10

Worse No Change Better

How do you think tactical load impacts on your marksmanship with the rifle when compared to carrying no load:

-10 0 +10

Worse No Change Better

Table 1. Primary weapon marksmanship results from all four conditions

Task & Loading Condition	DCOT (mm)	X-Dispersion (mm)	Y-Dispersion (mm)
Short Forward Movement			
Fatigues Only	75.93 ± 17.97	112.50 ± 31.35	143.58 ± 44.88
Tactically Loaded	70.48 ± 19.57	76.42 ± 46.99	168.42 ± 50.39
Mobility Task			
Fatigues Only	74.83 ± 36.95	116.67 ± 70.05	173.25 ± 139.65
Tactically Loaded	100.10 ± 20.14	112.50 ± 51.59	213.67 ± 70.99

Data are mean ± standard deviation

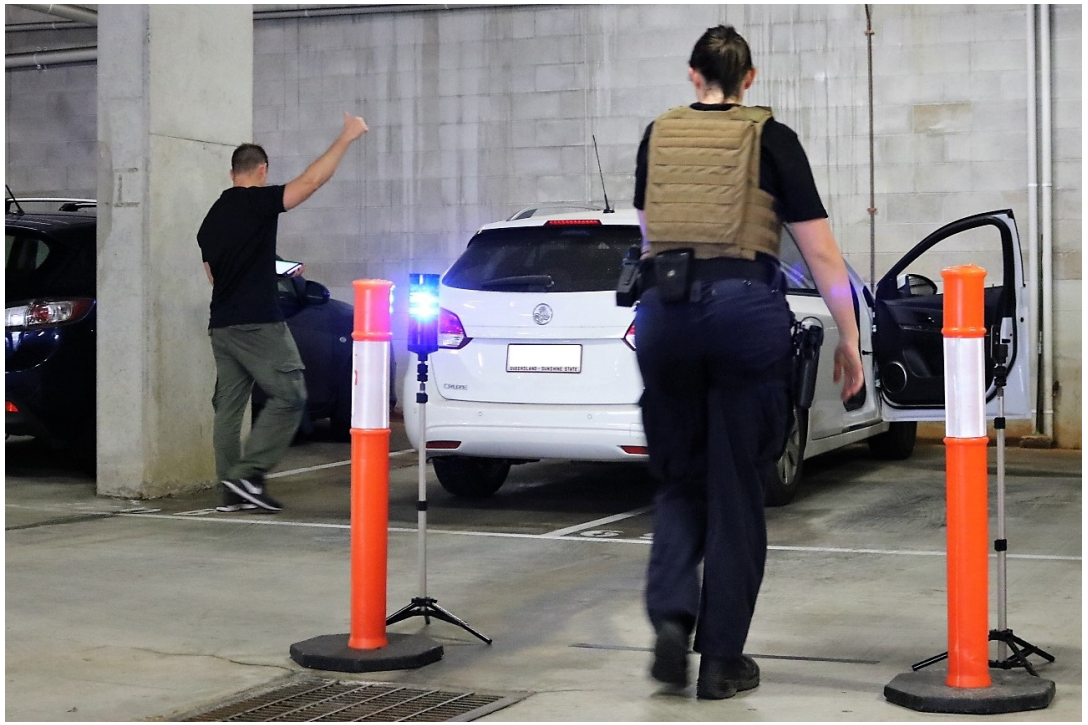
Table 2. Secondary weapon marksmanship results from all four conditions

Task & Loading Condition	DCOT (mm)	X-Dispersion (mm)	Y-Dispersion (mm)
Short Forward Movement			
Fatigues Only	107.35 ± 37.68	178.33 ± 81.62	206.33 ± 85.87
Tactically Loaded	112.60 ± 44.37	128.83 ± 59.55	188.25 ± 60.23
Mobility Task			
Fatigues Only	128.23 ± 33.20	157.00 ± 70.43	274.08 ± 176.61
Tactically Loaded	108.70 ± 52.48	176.25 ± 70.13	212.08 ± 131.60

Orr, R. M., Poke, D., Stierli, M., & Dawes, J. (2018). The perception of the impact of load carriage on marksmanship performance in specialist police. *Journal of Australian Strength and Conditioning*, *26*(4), 47-55.

CURRENT CONTEXT – IMPACTS

- Decrements in performance:
  - ↓ Mobility + ↓ Lethality – Even with light body armour



Tomes, C., Orr, R. M., & Pope, R. (2017). The impact of body armor on physical performance of law enforcement personnel: a systematic review. *Annals of occupational and environmental medicine*, *29*(1), 1-15.

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CONDITIONING AND RECONDITIONING

- Conditioning concept is not new (Flavius Vegetius Renatus - *Epitoma rei militaris)*

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CONDITIONING AND RECONDITIONING

F.I.T.T Formula (Frequency, Intensity, Time & Type)

- F. 10-14 days per load carriage session
- I. To loads required (Last decade 40-50kg) at the speeds and over the terrains required
- T. Duration of load carriage operations
- T. Load carriage preferable, but combined resistance and cardio may be of some benefit

CONDITIONING AND RECONDITIONING

Measure	Pack March 1 (mins:sec)	Pack March 2 (mins:sec)	Pack March 3 (mins:sec)
Pack March 1 (mins:sec)	1	.840**	.815**
Pack March 2 (mins:sec)	.840**	1	.881**
Pack March 3 (mins:sec)	.815**	.881**	1
Shuttle Run (Level)	-.712**	-.709**	-.711**

Robinson, J., Roberts, A. Irving, S. & Orr., R. (2018). Aerobic fitness of greater importance than strength in load carriage performance. International Journal of Exercise Science 11(4): 987-998

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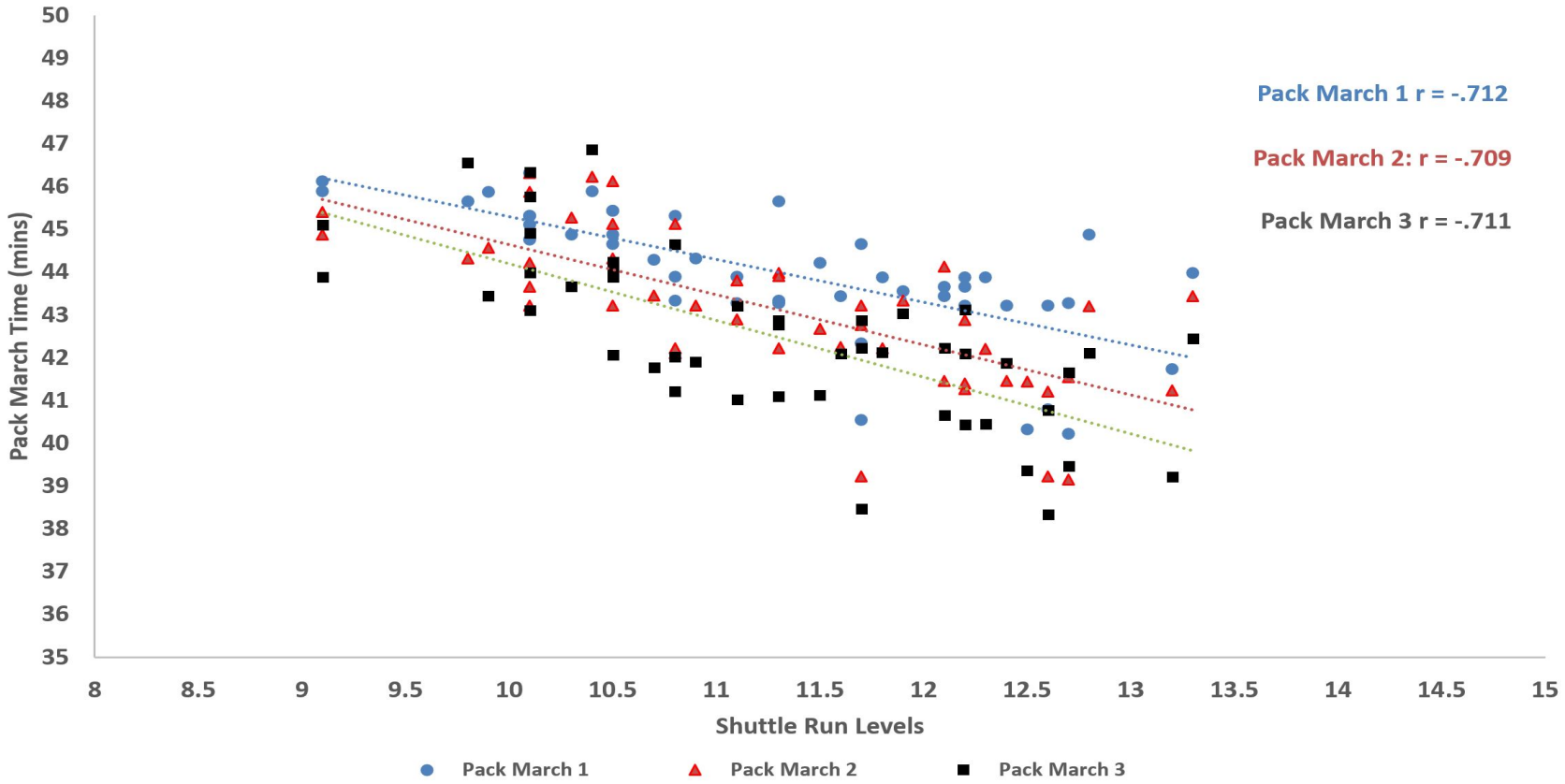
CONDITIONING AND RECONDITIONING



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CONDITIONING AND RECONDITIONING

Manipulating the Variables

- Increase metabolic cost without increasing the load weight / weight bearing status
  - Same load weight but increase speed, incline or change terrain
  - E.g. 15 kg but increase speed from 5.0 km/h to 5.5 km/h
- Increase load weight / weight bearing status but without over exertion
  - Increase load weight but reduce speed or incline etc
  - E.g. 15 kg to 20 kg but from 5.0 km/h reduce to 4.5 km/h

CONDITIONING AND RECONDITIONING

Measure	Pack March 1 (mins:sec)	Pack March 2 (mins:sec)	Pack March 3 (mins:sec)
1RM Bench Press (kg)	-.360*	-.318*	-.295*
Bench Ratio (%)	-.465**	-.365*	-.379**
1RM Squat (kg)	-.401**	-.335*	-.316*
Squat Ratio (%)	-.500**	-.381**	-.396**
1RM Deadlift (kg)	-.288*	-0.248	-0.215
Deadlift Ratio (%)	-.403**	-.294*	-.305*
1RM Pull-up (kg)	-.452**	-.439**	-.416**
Pull-up Ratio (%)	-.607**	-.512**	-.541**
Vertical Jump (cm)	-.501**	-.541**	-.523**
10 meter sprint	.373*	0.178	0.217

** Correlation is significant at the 0.01 level (2-tailed).

Robinson, J., Roberts, A. Irving, S. & Orr., R. (2018). Aerobic fitness of greater importance than strength in load carriage performance. International Journal of Exercise Science 11(4): 987-998

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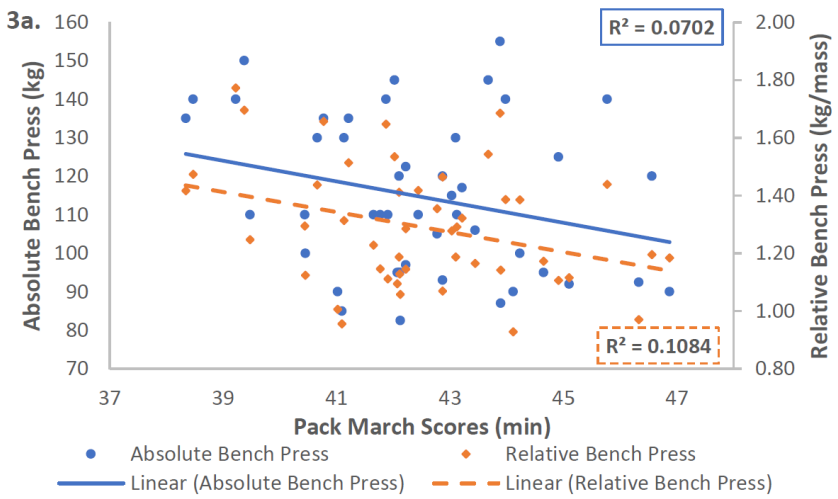
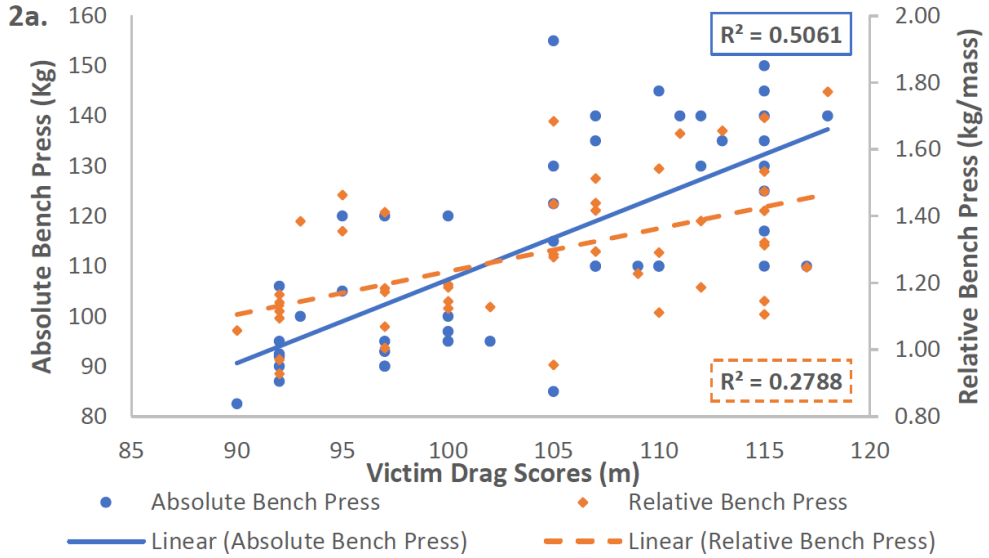
CONDITIONING AND RECONDITIONING





Orr., R., Robinson, J., Hasanki, K., Talaber, K., Schram, B. & Roberts, M. (post review) The Relationship between Strength Measures and Task Performance in Specialist Tactical Police. Journal of Strength and Conditioning Research

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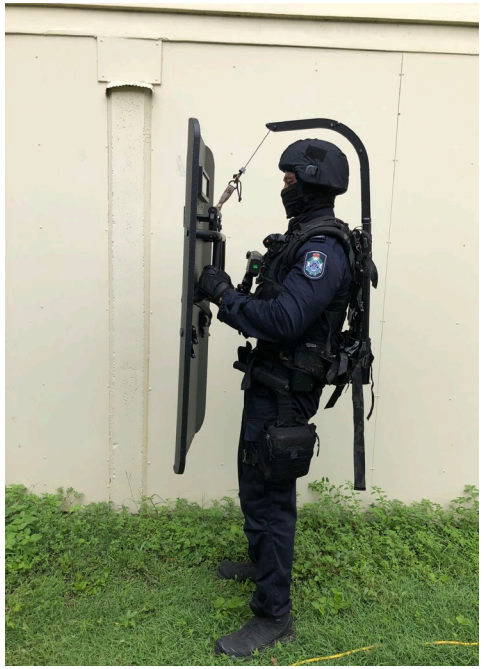
CONDITIONING AND RECONDITIONING



CONDITIONING AND RECONDITIONING

- Law Enforcement Injuries *(Orr, et al., 2015)*
  - Physio treatment

- **Age**: Police officers 45 – 54 yrs of age → 35.7 % (n=15) of cases
  - ~88% (n=37) cases between 25-54 yrs of age
- **Rank**: Sergeant → 26.2% (n=11), Senior Constable → 23.8% (n=10)
- **Years of Service**: 0 – 10 yrs → 35% (n=14), 11- 20 yrs → 30% (n=12)
- **BMI**: 57.5% (n=23) → 25.0 – 29.9 (overweight)
- **LBV**: 31% (n=13); **No LBV**: 69% (n=29)
  - Low back injury > when no LBV used vs. when LBV used (44.8% vs. 30.8%)
- **Thigh Holster**: 35.7% (n=15); **Hip Holster**: 64.3% (n=27)
  - Low back injury > when hip holster used vs. when thigh holster used (44.4% vs. 33.3%)

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	Shuttle Run	Vertical Jump (cm)	Grip Strength (kg)	Leg Dyno (kg)
Static Score	0.528**	0.322	-0.001	0.343
Dynamic Scenario	0.170	-0.022	-0.367*	-0.069
Positive ID Scenario	0.009	0.221	0.040	0.344*
Scenario Combined	0.062	0.181	-0.153	0.286
Total Score	0.220	0.255	-0.129	0.350*

Muirhead, H., Orr, R.M., Schram, B., Kornhauser, C., Holmes, R. & Dawes, J.J. (2019). The Relationship between Fitness and Marksmanship in Police Officers. Safety 5(3), 54; https://doi.org/10.3390/safety5030054 (registering DOI)

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	Static Score	Dynamic Scenario	Positive Identification Scenario
Static Score	-	0.314	0.281
Dynamic Scenario	0.314	-	0.177
Positive Identification Scenario	0.281	0.177	-

Muirhead, H., Orr, R.M., Schram, B., Kornhauser, C., Holmes, R. & Dawes, J.J. (2019). The Relationship between Fitness and Marksmanship in Police Officers. Safety 5(3), 54; https://doi.org/10.3390/safety5030054 (registering DOI)

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- PICO

Orr R, Knapik J, Pope R. Avoiding Program-Induced Cumulative Overload (PICO). Journal of Special Operations Medicine: A peer reviewed journal for SOF medical professionals 16(2):61-4, 2016.

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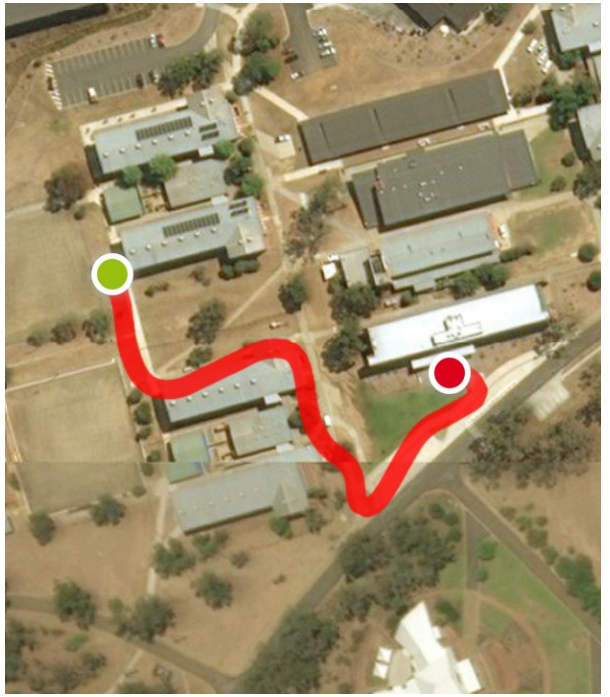
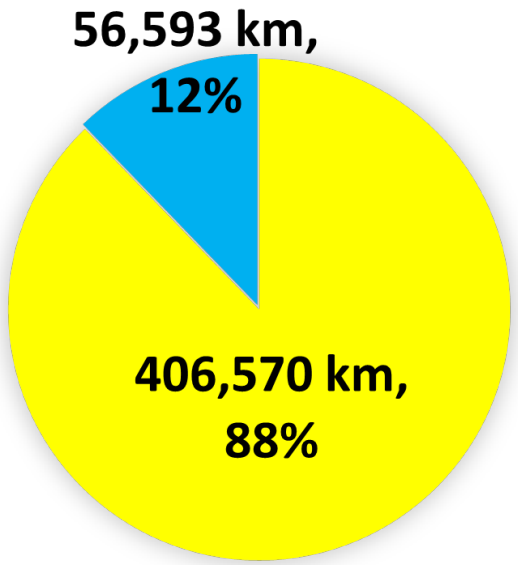
- PICO

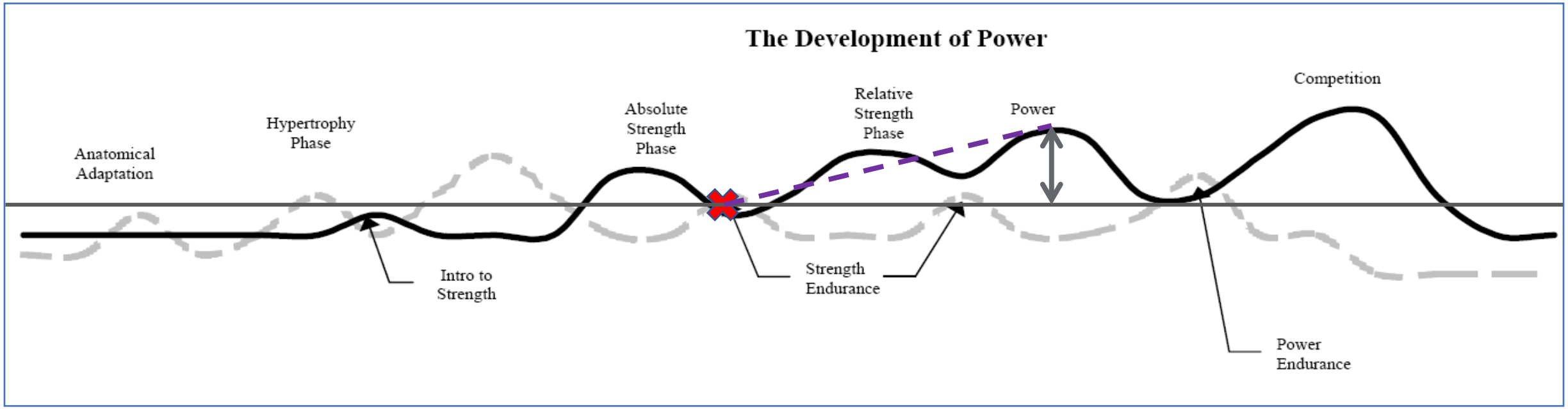




Orr, R., Schram, B., Canetti, E., & Pope, R. (2020, February). Distances travelled during recruit physical training: A drop in the bucket. In *5th International Congress on Soldiers' Physical Performance*.

CONDITIONING AND RECONDITIONING

Return to training/service?



THANK YOU FOR YOUR SERVICE

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